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ACUTE RODENTICIDES IN THE CONTROL OF RODENT PEST IN CHINA: A REVIEW

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INTRODUCTION

In China, the earliest record, "The Book of Song," vividly describes that farmers complained of rodent damage and earnestly hoped rodents did not eat their crops. It will be seen from this that since the spring and autumn period (770-476 B.C.), rats, mice and voles have been among the major problems of China.

It is said that there are 400 species of mammals in China and 150 species of them are rodents, of which 25-30 species of rodents are usually considered serious pests. Large amounts of grassland, forests and agricultural crops are destroyed or seriously damaged every year. There is no accurate estimation of the total loss. According to the Xia Wuping's report (1976), a great outbreak of house mice occurred in the agricultural fields in Northern Xinjiang during 1967-1968. The loss of crops due to house mice was roughly estimated at 300 million Jin (equal to 150 million kg.). During a survey taken in the grassland in Qinghai Province, it was shown that a population of 16.5 plateau pikas (Ochotona curzoniae Hodgson) per Mu (a unit of area equal to 0.0667 hectares) caused 50% of damage to grasses.

The first acute rodenticides used for rodent control were white arsenic and yellow phosphorus (Horng 1959, Ku 1982). These have now been replaced by more suitable chemicals.

Acute rodenticides have had a relatively long history of use in China and have played a very important role in rodent pest control. But, at the moment, some of them are becoming a subject of heated dispute and the target of public criticism. Therefore people follow with interest the development of debate and pay close attention to the future and destiny of acute rodenticides.

In this paper I will briefly look back at the history of acute rodenticides used in China and evaluate their achievements and errors.

GENERAL SITUATION OF MANUFACTURE AND APPLICATION OF ACUTE RODENTICIDES

Since the 1950s China has trial-produced and manufactured 18 kinds of acute rodenticides, and they have been tested on a total of 22 rodent species in the lab or field.

1) Zinc phosphide is probably the acute rodenticide most widely used for both field and commensal rodents throughout China. The toxicity of zinc phosphide is not significantly different among the various species but toxicity of zinc phosphide is in close relationship with sex, age and ecological period of the daurian ground squirrel, Citellus dauricus. The results show in Table 1 that the most tolerant group of the daurian ground squirrel to the LD_{50} of zinc phosphide is pregnant females (Xia 1976, Wang 1981).

Table 1. LD_{50} of zinc phosphide for the daurian ground squirrel (Citellus dauricus) during various ecological periods (From Wang Chengxin, 1981).

Ecological periods	Male (mature)		Female (mature)	Young
end of hiberation	36.32		-	-
pregnant	22.30		about 60	-
lactating	about 20		about 20	-
dispersal age		24.34*		10.59
fatling		22.16*		14.22

* There are not significant differences between male and female, the results represent both male and female.

With the increasing use of zinc phosphide for the control of pests, people discovered that rodents not only easily established a conditional reflex to poison baits, but that they also kept this kind of conditioned reflex for a long time. Some commensal rodents that survived remained bait-shy for more than 3 months. Daurian ground squirrels that survived were bait-shy even after hibernation (Wang 1981).

In spite of the fact that both field and commensal rodents developed bait-shyness and secondary poisoning occurred, zinc phosphide is still a common rodenticide because it is rather cheap, is produced easily, and because of its mode of action. Some Chinese scientists have pointed out that if zinc phosphide and other effective rodenticides can be used alternately, they will still be effective (Wang 1981; Health Anti-Epidemic Station, Zhan-Jiung Region, Quang-dong Province, 1978).

2) 1081 (Fussol, Fluorakil) is the second most widely used rodenticide for both commensal and field rodents, especially for control of common Chinese zokers, *Myospalax fontanieri* (Table 2) which is an important agricultural field, plantation and grassland pest, particularly in the North and Northwest China (Wang Zuwang 1972, Liang 1978).

Table 2. LD_{50} of 1081 (Fussol, Fluorakil) to various species.

Species	LD_{50} (mg/kg)	Source
Plateau pikas (*Ochotona curzoniae*)	0.71	Research Group, 1973[a]
Common Chinese zokers (*Myospalax fortanieri*)		Research Group, 1973[a]
Norway rat (*Rattus norvegicus*)	13.0	Wang C., 1981
Taiwan rat (*Rattus losea*)	6.67-22.8	Wang C., 1981
Buff-breasted rat (*Rattus flavipectus*)	16.87	Yang, 1981
Daurian ground squirrel (*Citellus dauricus*)	0.40[b]-0.46[c]	Wang C., 1981
Striped field mouse (*Apodemus agrarius*)	27.74	Wang C., 1981
Large Japanese mouse (*Apodemus speciosus*)	7.53	Forest Management Team, 1978[d]
Large-toothed red-backed vole (*Clethrionomys rufocanus*)	32.02	Forest Management Team, 1978[d]
Domestic rabbit	0.55	Wang C., 1981
Sheep	1.5	Wang C., 1981
Dog	0.5	Wang C., 1981
Guinea pig	5	Wang C., 1981

[a] Research Group for Control of Rodents, 1973; [b] young; [c] adult; [d] Forest Management Team, Forest Science Institute, Dai-Ling, Heilongjiang Province, 1978.

Common Chinese zokers lead a completely subterranean existence so people find it hard to offer the poison baits. To counter this situation, Chinese scientists advanced that people can spray 0.2% solution of 1081 in the grasses because 1081 is a strong inner-absorptive rodenticide which can be absorbed and transmitted by grasses from the above ground leaves and stems to the underground roots. 1081 remains in the grasses only for a short time. The tests show that the effective period 1081 remains is 15 days and that the spray method is the most effective method of controlling fossorial rodents. The average efficiencies (Table 3) are more than 90% (Fan 1981, Shi and Gai 1981).

1081 is also used to control rodents in plantations, agricultural fields and farmers' homes. Efficiencies are 82 to 98% (Table 3) (Forest Management, Forest Sciences Institute, Dai-Ling, Heilongjiang Province, 1978; Zhang 1981, Yang 1981, Shi et al. 1981).

Chinese scientists also have paid much attention to the study of an antidote to 1081. They found that acetylamine is a wonderful antidote which has saved many humans and livestock (Research Group for Chemical Control of Rodents 1973).

Table 3. The results of field test conducted on pest rodent species with several different acute rodenticides.

Acute rodenticides	Species	Site	Province	Efficacy (%)
Zinc phosphide				
10% zinc phosphide + pine nut	Apodemus agrarius A. speciosus Clethrionomys rufocanus C. rutilus Micromys minutus	forest	Heilongjiang (Northeast China)	90.47-92.30
10% zinc phosphide + naked oats	Microtus brandti Citellus dauricus Allactage sibirica	grassland	Inner Mongolia Autonomous Region (Northern China)	85-98
8.0% zinc phosphide + naked oats	Ochotona daurica	grassland	Qinghai	68.6-71.2
	Ochotona curzoniae	grassland	(Northwest China)	50.3
5.0% zinc phosphide + wheat		agricultural field	Xinjiang Uygur Autonomous Region (Northwest China)	85
3-5% zinc phosphide + sweet potato or rice	Rattus losea	farmer's home	Guangdong (South China)	85
	Rattus flavipectus	farmer's home	" "	85
1080				
0.6% 1080 + rice	Apodemus agrarius Rattus norvegicus Mus musculus Rattus flavipectus	agricultural field	Wuhan (Central China)	92
1081				
0.20% spray	Myospalax fontanieri	grassland	Qinghai (Northwest China)	93.3
0.32% 1081 + wheat	Ochotona curzoniae	"	" " "	100.0
0.16% 1081 + wheat	Ochotona curzoniae	"	" " "	97.4
0.08% 1081 + wheat	Ochotona curzoniae	"	" " "	90.4
0.6% 1081 + pine nut	Apodemus agrarius A. speciosus Clethrionomys rufocanus C. rutilus Micromys minutus	forest	Heilongjiang (Northeast China)	93-95
0.2% 1081 + potatoes	Myospalax fontanieri	forest	Ninghsia (Northwest China)	88.9
0.2% 1081 + green Chinese onion	M. fontanieri	forest	" " "	81.8
0.5% 1081 + naked oats	Meriones unguiculatus	grassland	Inner Mongolia	98.45
0.5% 1081 + corn	Rattus flavipectus	farmer's home	Yunnan (Southwest China)	84.4
Mesulmine				
0.2% mesulmine + oats	Ochotona curzoniae	grassland	Qinghai (Northwest China)	82.1
0.1% " "	Ochotona curzoniae	grassland	" " "	79.9
Gophacide				
0.5% gophacide + naked oats	Meriones unguiculatus	grassland	Inner Mongolia	92.9
0.1% " "	M. unguiculatus	grassland	" "	94.6
1.0% gophacide + naked oats	Ochotona curzoniae	grassland	Qinghai	91.5
0.5% gophacide + naked oats	O. curzoniae	grassland	"	91.4
2.0% gophacide naked oats	O. curzoniae	grassland	"	94.9
2.0% gophacide + corn	Rattus flavipectus	farmer's home	Yunnan	50.0

CONT.

(Table 3 continued)

Acute rodenticides	Species	Site	Province	Efficacy (%)
QH203 & QH205				
0.25% QH203 + oats	Ochotona curzoniae	grassland	Qinghai	89.3
0.50% QH203 + oats	" "	grassland	"	92.6
0.50% QH203 + oats	Meriones unguiculatus	grassland	Inner Mongolia	79.1
1.0% QH205 + oats	M. unguiculatus	grassland	" "	86.5
2.0% QH205 + oats	M. unguiculatus	grassland	" "	73.8
A series of rodenticides:				
2% LH106 + corn	Citellus dauricus	grassland	Inner Mongolia	87.8
1-2% LH106 + oats	Ochotona daurica	grassland	Qinghai	87.7-89.0
2% LH107 + oats	Ochotona daurica	grassland	Qinghai	72.9
1.0% LH104 (RH945) + naked oats	Meriones unguiculatus	grassland	Inner Mongolia	83
1.0% LH104 (RH945) + baked cake	Mus musculus Rattus norvegicus Rattus flavipectus	farmer's home	Fujian (East South China)	89-92
1.0% LH104 (RH945) + sweet potato	Rattus losea	rice field	Fujian " " "	80
1% LH105 (RH-787) + sweet potato	Rattus losea	rice field	Fujian	85
Gliftor				
0.25% gliftor + oats	Ochotona curzoniae	grassland	Qinghai	97.3
0.50% gliftor + oats	O. curzoniae	grassland	"	98.9
1.0% " "	O. curzoniae	grassland	"	100.0
0.05% spray	O. curzoniae	grassland	"	80
0.5% gliftor + wheat	Lagurus luteus	grassland	Xinjiang Uygar Automous Region	77.5

3) Gliftor ($C_3H_6OF_2$ and C_3H_6ClOF) is a mixture which consists of 70%-80% glycerol α γ - difluohydrin and 30-20% glycerol α-chlor-γ-fluorohydrin. The chemical structure is as follows:

$$\mathrm{F-CH_2-\underset{\displaystyle OH}{\underset{|}{CH}}-CH_2F} \quad \text{and} \quad \mathrm{Cl-CH-\underset{\displaystyle OH}{\underset{|}{CH}}-CH_2F}$$

Gliftor is a colorless or yellowish, oily liquid substance which is water, alcohol and ether soluble and has a tart flavor (Research Group for Chemical control of Rodents, 1973). It was manufactured by the Institute of Lu-Da Chemical Industry in the 1960s. The scientists of Northwest Plateau Institute of Biology, Academia Sinica, made a systematic study involving toxicity, antidotal, field and remnant effect tests, and evaluated the practicability of Gliftor (Tables 3 and 4) (Research Group for Chemical Control of Rodents 1973).

Some outstanding characteristics of the toxicity of Gliftor are that: a) it has a rather wide variation of susceptibility between commensal rodents and field rodents; b) in general, poultry are rather tolerant to Gliftor; and c) Gliftor exhibits a high degree of absorption to leaf, stem and root tissues. Since it is a volatile liquid, in tests conducted in the grassland in Qinghai Province, Gliftor exhibited no measurable toxicity after 113 days (Research Group for Chemical Control of Rodents 1973). They also found that acetylamine is an effective antidote for first aid treatment for humans and livestock.

Table 4. LD_{50} of Gliftor to various species.

Species	LD_{50} (mg/kg)	Source
Plateau pikas (Ochotona curzoniae)	3.38, 1.73	Research Group, 1973[a]
Norway rat (Rattus norvegicus)	30.0	Wang C., 1981
Taiwan rat (Rattus losea)	31.3	Health Anti-Epidemic Station, 1978[b]
Daurian ground squirrel (Citellus dauricus)	4.5	Wang C., 1981
Common Chinese zokers (Myspalax fortanieri)	2.79	Research Group, 1973[a]
Clawed jird (Meriones unguiculatus)	10.0	Wang C., 1981
Guinea pig (Cavia porcellus)	3.99	Research Group, 1973[a]
Dog	6.0[c]	Research Group, 1973[a]
Domestic rabbit	10.0	Wang C., 1981
Sheep	4.0	Wang C., 1981
Chicken	1500.0	Wang C., 1981
Duck	2000.0	Wang C., 1981
Rhesus monkey (Macaca mulatta)	5.0	Research Group, 1973[a]
Yellow steppe lemming (Lagurus luteus)	5.0	Research Group, 1973[a]

[a] Research Group for Control of Rodents, 1973; [b] Health Anti-Epidemic Station, Zban-Giung Region, Quangdon Province; [c] LD_{100}.

4) A series of pyridyl phenylcarbamate rodenticides. Since the 1970s the Institute of Lu-Da Chemical Industry started to synthesize and manufacture a new series of pyridyl phenylcarbamates rodenticides: LH104(RH-945), LH105(RH-787, Vacor), LH106, LH107.

In 1975-1976, Chinese scientists began laboratory and field evaluations. It is said that some of them are relatively selective and highly effective signle-dose rodenticides. The research dealt with toxicity tests, field tests, tolerance tests, and antidotal tests.

The toxicity of LH104(RH-945) was tested extensively in the laboratory on 12 species of rodents. Research has shown that the clawed jird (Meriones unguiculatus), striped field mouse (Apodemus agrarius), and tamarisk gerbil (M. tamariscinus) are most susceptible to LH104. Wild Norway rats, house mice, Taiwan rat (Rattus losea), and Brandt's vole (Microtus brandti) are slightly less susceptible to the LH104; plateau pikas, roof rats and yellow steppe lemmings (Laguras luteus)are not susceptible (Table 5) (Fan and Shi 1981, Wang C., 1981).

LH104(RH-945) was successfully used for controlling clawed jird, striped field mouse, Taiwan rat and buff-breasted rat (Rattus flavipectus) in agricultural fields (Tables 3 and 5) (Wang C. 1981, Zhan 1981).

The toxicity and field tests of LH105 (RH-787, Vacor) were tested in the laboratory and agriculture field on six species. Results both in the laboratory and field were excellent with clawed jird and black rat (R. rattus) and were fair to good with the Taiwan rat and buff-breasted rats (Tables 3 and 5) (Wang C. 1981, Fan et al. 1981, Zhan 1981).

LH106 and LH107 are being developed by the Institute of Lu-Da Chemical Industry. Up until the present moment the Chinese scientists have tested the toxicity of LH106 to 11 species of rodents. Results show that clawed jird, buff-breasted rat, Taiwan rat, plateau pikas (Ochotona curzoniae), common Chinese zokers (Myspalax fontanieri), yellow steppe lemming (Lagurus luteus) and house mice are very susceptible to LH106. Migratory hamster (Cricetulus migratorius) and daurian ground squirrel (Citellus dauricus) are also susceptible to LH106. Therefore LH106 was considered as a broad-spectrum rodenticide which is more toxic to various species of rodents than LH104 (RH-945) and LH105 (RH787) (Table 5) (Fan et al. 1981). According to other reports, LH106 was successfully used for controlling daurian ground squirrel (Bian et al. 1981) and plateau pikas in grassland (Fan et al. 1981) (Table 3).

The toxicity of LH107 was tested on four species of rodents: plateau pika, Taiwan rat, buff-breasted rat and clawed jird. The results of the toxicity test were excellent with plateau pika and fair to good with clawed jird and buff-breasted rat (Table 5), but the field test with plateau pikas was less than anticipated, based upon the LD_{50} test. The efficacy is only equal to zinc phosphide (Table 3) (Fan et al. 1981).

Table 5. LD_{50} of four different pyridyl phenylcarbamate rodenticides to various species.

Species	LH104 (RH945)	LH105 (RH787)	LH106	LH107	Source
plateau pikas (*Ochotona curzoniae*)	59.71	35.95	9.44	13.08	Fan et al., 1981
house mice (*Mus musculus*)	24.0	45.0	16.93	-	Zhan, 1981
Norway rat (*Rattus norvegicus*)	17.8	4.75	-	-	Zhan, 1981; Wang C., 1981
Taiwan rat (*Rattus losea*)	22.8	24.6	8.2	33.4	Zhan, 1981; Wang C., 1981
buff-breasted rat (*Rattus flavipectus*)	35.6	25.7	7.6	27.3	Zhan, 1981
roof rat (*Rattus rattus*)	83.0	18.2	-	-	Wang C., 1981
daurian ground squirrel (*Cittellus dauricus*)	65.4	-	23.1	-	Bian et al., 1981
Brandt's vole (*Microtus brandti*)	22.8	-	-	-	Wang C., 1981
Striped field mouse (*Apodemus agrarius*)	9.4	-	-	-	Wang C., 1981
Migratory hamster (*Cricetulus migratorius*)	-	-	28.30	-	Fan et al., 1981
common Chinese zokers (*Myspalax fontanieri*)	-	-	11.07	-	Fan et al., 1981
red-tailed jird (*Meriones erythrourus*)	-	-	12.07	-	Fan et al., 1981
Tamarisk gerbil (*M. tamariscinus*)	-	-	10.05	-	Fan et al., 1981
clawed jird (*M. unguiculatus*)	5.9	16.5	4.7	23.4	Wang C., 1981
yellow steppe lemming (*Lagurus luteus*)	60	-	13.55	-	Fan et al., 1981

Four kinds of pyridyl phenylcarbamate rodenticides appear more palatable and bait-shyness was not evident. Chinese scientists support findings of Marsh and Howard (1975) and further indicate that the four kinds of pyridyl phenylcarbamates are not accumulative rodenticides (Bian et al. 1981, Fan et al. 1981).

In the tolerance tests, two groups of plateau pikas (20 animals per group) were used. One group was not treated temporarily as a control group; another group was offered sublethal dosage of LH104 (RH 945) or LH106. Both groups were observed for 3 to 5 days. After no symptoms appeared, the two groups were offered LD_{50} dosage of LH104 or LH106, and the mortality of two groups were then compared. Results of the tolerance tests clearly shows that plateau pikas do not become tolerant to LH104 (RH-945) and LH106 (Table 6) (Fan et al. 1981).

Table 6. Tolerance test of LH104(RH945) and LH106 on plateau pikas (From Fan et al. 1981).

	LH104		LH106	
	Control group	Tested group	Control group	Tested group
No. of animals	20	20	20	20
Results of test (No. of dead animals/No. of survived animals)	9/11	12/8	11/9	10/10
% mortality	45	60	55	50
Comparison of mortality	$t = \frac{\lvert P_1-P_2 \rvert}{SP_1-P_2}$ df$=n_1 + n_2 - 2$ $t=0.951$; $t_{0.05}=2.017$ $\therefore\ t < t_{0.05}$		$t = 0.306$; $t_{0.05} = 2.017$ $\therefore\ t < t_{0.05}$	

Chinese scientists had considered that naicotionamide can detoxify to LH104(RH945) and LH105 (RH787), because it is hydrogen-acceptor of DPN and TPN, and it is absolutely necessary matter in biological oxidation (Zhan 1981).

In general, a new series of pyridyl phenylcarbamate rodenticides is considered more effective and safer than any other acute rodenticides, especially LH106 which, as previously indicated, is but one of a series of promising rodenticides.

Beside above-mentioned, Chinese scientists have also synthesized and applied some other acute rodenticides, such as Mesulmine (Telramine), silatrance RS 150, RS 100, Gophacide Bayer 38819 and its derivative QH 203, QH205, QH206 (Tables 3 and 7) (Xia 1976, Fan et al. 1981, Wang C. 1981, Yang 1981).

Table 7. LD_{50} of the 8 acute rodenticides to various species

Species	1080	Mesulmine	Gophacide (Bayer 38819)	QH 203	QH 205	QH 206	Silatrance RS150	Silatrance RS100	Source
plateau pikas (Ochotona curzoniae)	-	0.249	7.85	3.19	5.9	38.7	3.0	16.9	Xia 1976 Fan et al. 1981
house mice (Mus musculus)							0.9	2.0	Wang C. 1981
Norway rat (Rattus norvegicus)	0.22	-	3.5	-	-	-	1.0-4.0	-	Xia 1976
Taiwan rat (Rattus losea)	-	-	16.9	-	-	-	1.63	-	Wang C. 1981
buff-breasted rat (Rattus flavipectus)	1.8	-	23.44	-	-	-	-	-	Wang C. 1981 Yang 1981
daurian ground squirrel (Citellus dauricus)	0.3	0.25	16.9	-	-	-	-	-	Wang C. 1981
striped field mouse (Apodemus agrarius)	2.64	0.93	-	-	-	-	3.70	-	Wang C. 1981
striped hamster (Cricetulus barabensis)	-	0.52	-	-	-	-	-	-	Wang C. 1981
clawed jird (Meriones unguiculatus)	0.65	0.66	11.6	-	-	-	4.0	-	Xia 1976
Bandicoot rat (Bandicota neumoriyagn)	-	-	7.0	-	-	-	-	-	Wang C. 1981
Brandt's vole (Microtus brandti)	-	-	12.1	-	-	-	-	-	Wang C. 1981

CHINESE HERBAL MEDICINE FOR CONTROLLING RODENT PESTS

The oldest method of rodent control was by traditional herbal medicine means. Chinese farmers like to use certain herbal medicine in the control of rodent pests. They think herbal medicines are very cheap, safe and of rich source. It is said that there were 12 to 15 herb species used for controlling rodent pests (Table 8) (Fig. 1-4), and most of them appeared of rather lower efficacy in the field tests when they were used directly because of their rather poor palatability. But there was an exception: Rhododendron molle was used for making the fumigants to kill striped field mouse and control was excellent (Xia 1976, Wang C. 1981).

Table 8. Some herbal medicine (plants) used for rodent control in China.

Plant species	Effective parts	Effective composition
Pulsatilla chinensis(Bunge) Regel	root & stem	pulsatillin & pulsatillin acid
Stellera chamaejasme L.	root	stellerin
Sophora flavescens Ait	rhizome	cytisine
Cerbera manghas L.	nucleolus	cerberin
Xanthium strumatium L.	seed	-
Datura innoxia Mill	fruit	-
Periploca sepium Bunge	root bark	-
Dianella ensifolia DC.	root	-
Arisaema consanguineum Schott	stem tuber	-
Macleaya cordata Brown R	full grass	-
Strychnos nux-vomica L.	seed	strychnine
Rhododendron molle GDon	leaves	-

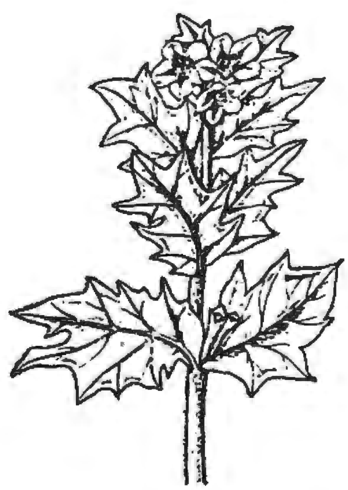

Fig. 1 Datura innoxia Milla

Fig. 2 Dianella ensifolia DC

Fig. 3 Cerbera manghas L.

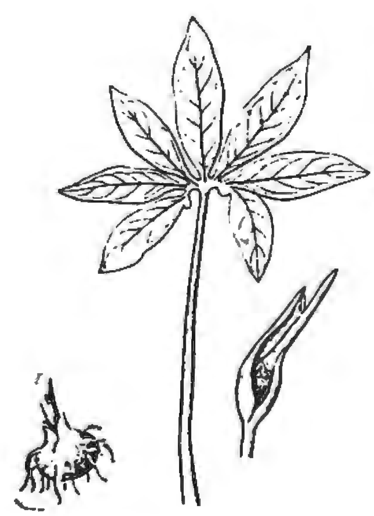

Fig. 4 Arisaema consanguineum Schott

Despite the fact that many herbal methods failed to control rodent pests in the field, scientists still can gain a good deal of enlightenment from the farmers' experience. Effective rodenticides might be developed by extracting and refining composition from the traditional herbal poison.

PROBLEMS AND FUTURE OUTLOOK

Some acute rodenticides, such as zinc phosphide, 1081, Gliftor and others, are toxic to both target and nontarget species. Zinc phosphide and 1081, especially, are probably the acute rodenticides most widely used for both field and commensal rodents in China.

Zinc phosphide is poisonous to some degree to all animals and it does remain toxic for as long as several days in the guts of dead rodents. Other animals are poisoned if they eat enough of the gut of rodents recently killed with zinc phosphide. Therefore many primary or secondary poisoning accidents have occurred every year.

1081 is more toxic than zinc phosphide. It is generally agreed that secondary and even tertiary poisoning can be demonstrated with 1081. In summer of 1976, I noticed seven dead red foxes and some dead buzzards several weeks after 1081 poison baits were used by farmers in an alpine meadow. Wang C. (1981) also reported that some natural enemies of rodents, e.g., dogs, hawks, foxes and weasels were killed due to secondary poisoning. In addition, Mesulmine, the gophacide bayer 38819, and others also caused secondary poisoning (Fan et al. 1978).

I think the consequences mentioned above have been caused by the following reasons: (a) Chinese scientists have ability to synthesize new acute rodenticides but they have no ability to stop the anarchical application of rodenticides in this country. People always like to criticize some rodenticides which have become "scapegoats," but nobody wants to criticize the person who has abused the rodenticides; (b) China lacks the necessary trained manpower who can popularize and thus bring acute rodenticides into full play.

To simply stop usage or production of some acute rodenticides is a passive attitude. What is a positive attitude? I think that while speeding up the study on the more effective, safer new acute rodenticides, we must pay more attention to directions on how to use the old acute rodenticides and how to reduce the dangers of secondary poisoning and pollution of the environment to a minimum, because we cannot expect a panacea for all rodent control.

In order to change the anarchical situation in the rodenticides applied, we must establish and complete the laws and regulations pertaining to all aspects of rodent control. Some form of acute rodenticides control board should establish guidelines as to what rodenticides are to be used and in what way. How long should it be used and what kind of rodenticide can be used alternately should also be part of such guidelines.

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